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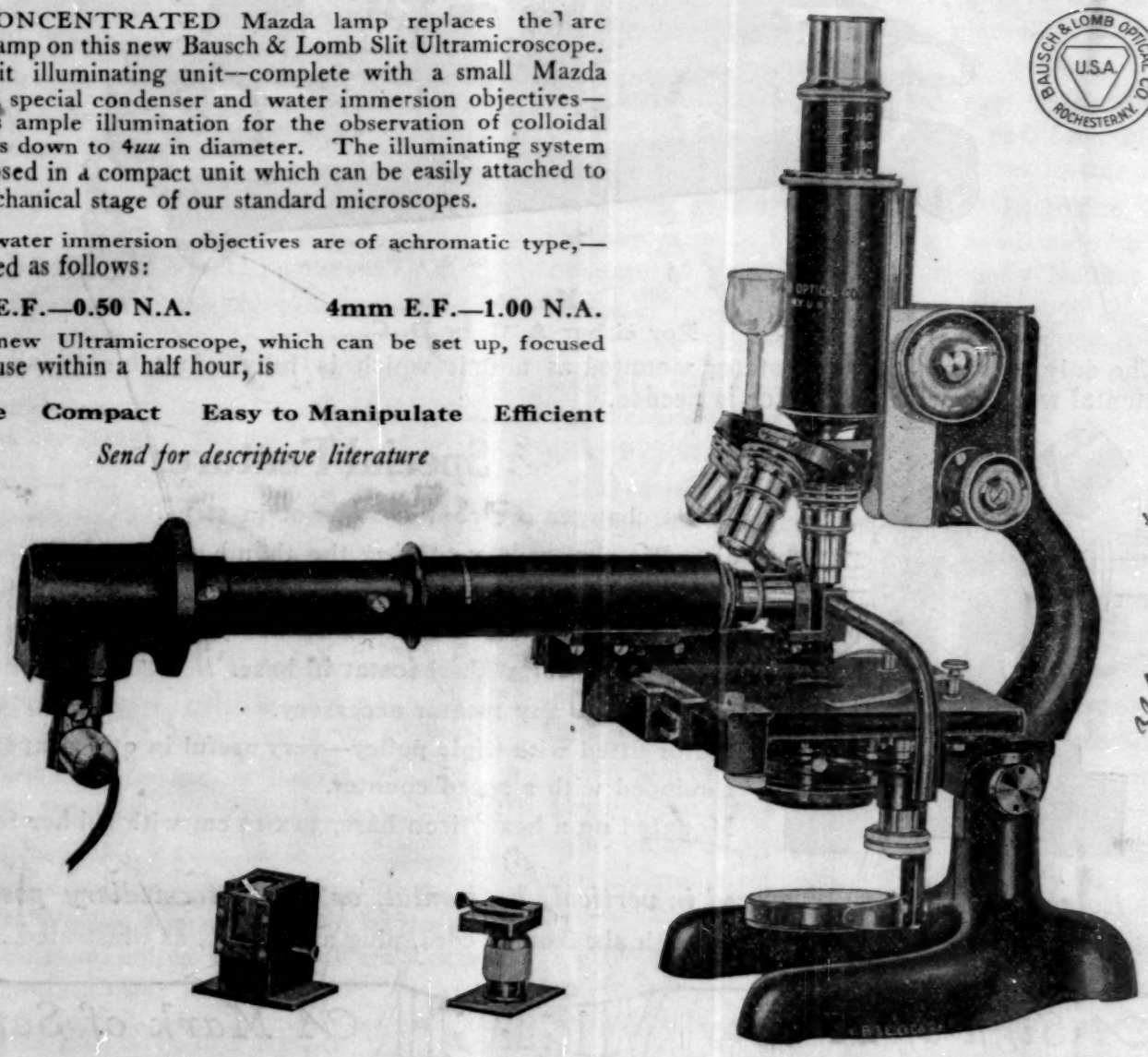

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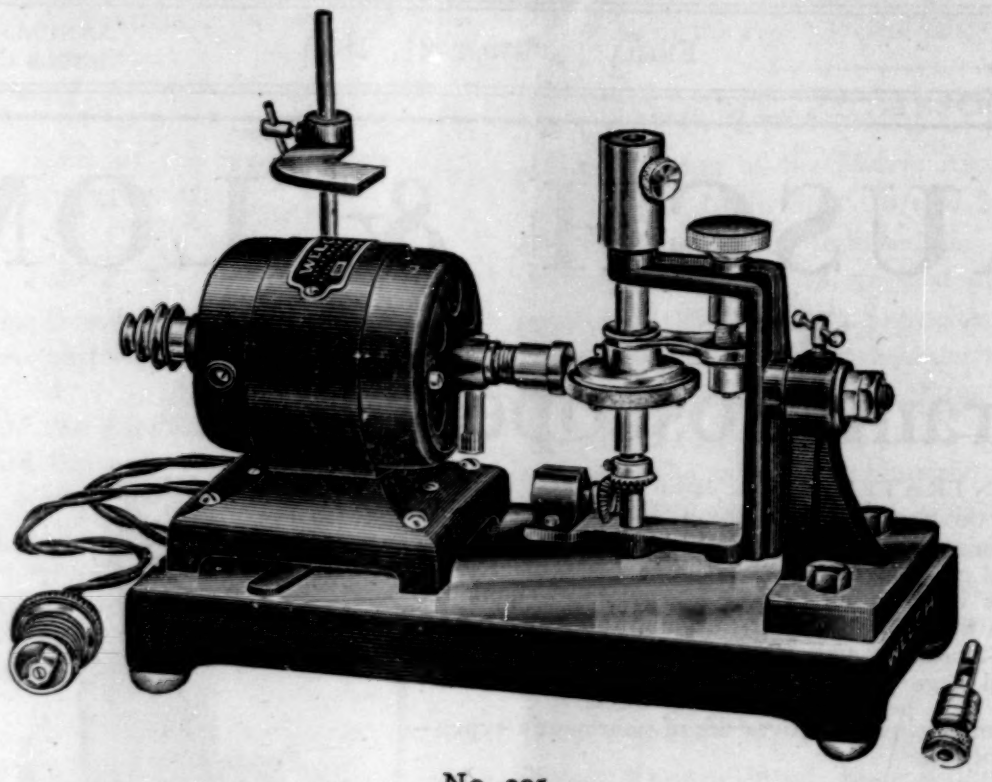

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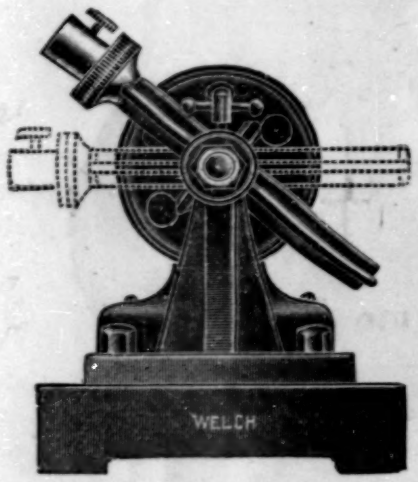

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SCIENCE

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RESEARCH IN THE SERVICE OF THE STATE[1]

EVERYTHING has a beginning—even commencement. This annual festival of American colleges which we celebrate to-day traces back centuries ago to the medieval universities, where in form it was quite different from the present-day commencement.

The antecedent of this occasion was known in medieval times as "inception," and marked the admission of the graduate to the career of teaching. Hence the custom was for those who received the bachelor's degree to be invested with the insignia of the new rank —often the cap and ring—be placed in the master's chair and "incept" or begin to teach. Our word *commencement* was borrowed from Cambridge University, where the earlier form had been modified, and the first commencement exercises in this country were held at Harvard in 1642. In course of time the day came to be not only of academic importance but one of great festivity, evidently leading to excesses at times, for we read that in 1722 sumptuary laws were passed in this state prohibiting "commencers" from providing refreshments or liquors in their chambers, with what success we need not inquire at this remote date.

The medieval formalities of "inception" later developed into the expounding of theses or the defense of dissertations by the graduates and still later into the delivery of orations. Latterly it has come to be a listening-in occasion for the graduating class and their friends alike, with an address by an outsider, an innovation which in my student days would have been a welcome relief. But the world continues to move, and still another change may be in store. Already we have courses of instruction given by radio which do away with the need of assembly; may not the radio commencement, therefore, be waiting just around the corner?

However, for the class of '25, this is your day and for all of you it marks an inception, if not into teaching into a new stage in the working out of a career. It is the close of a preparatory period which helps the student to find himself, to understand his relations to the world and inspires purpose within him. Higher education is still limited to the few, amounting to less than one per cent. of the entire population in this country, or only about two per cent. of those of adult age. Every twenty of you

[1] Commencement address delivered at the Massachusetts Agricultural College, June 15, 1925.

who graduate thus represent a group of one thousand adults, taken the country over, 980 of whom do not have the privilege of a college education and only 140 of whom finish high school. Hence the obligation this privilege implies.

The advantage of the college course to the individual and to society depends on his understanding of the purpose of education, the use he is prepared to make of it and the attitude it helps him to acquire toward life and growth. For college teaches men how to live and how to grow, as well as how to make a living. Education deals with what is known not merely for the information it gives, but as a means of looking forward and preparation to meet conditions the future will bring, realizing that the future will be very different from the present. In this sense, education prepares for future building, giving a receptive mind toward what is new. Away from the environment of study, absorbed in making his start in life, the graduate must fight against allowing himself to fall into a rut, against losing the challenge of his mind which makes him a live, effective individual, instead of a link in the chain to be used by others.

We recognize it as a law of nature that the tree, the plant, all living things, must continue to grow in order to live. Likewise the man must continue to grow and develop if he is to be a living factor; to advance with the forward movement of the world and our knowledge of it. And the same holds true for society and for the state. They must have within themselves the elements of progress which enable them to keep abreast of the times. This brings me to the central theme of my subject—research as a means of growth and power.

It is an old saying that what man doesn't know he doesn't worry about, but however blissful ignorance may be it usually turns out to be very expensive. Man has learned by hard experience that lack of knowledge has been the greatest source of his ills and worries and mistakes, and that the acquisition of knowledge is the surest way out. Most of what we know that is reliable, the epoch-making inventions that fire our admiration, a very large share of the material and intellectual progress of the world, rest back on the results of research—the determination of sound facts and their correct interpretation.

Research is the process by which we learn new things about the world and the forces around us, how to bring ourselves into harmony with them and how to use them. It discloses, as Carlyle said, "the inner harmony of things; what Nature meant."

Knowledge is a human product revealed to man through his efforts. It is built up for the most part by minute additions made by many workers. The French scientist, Berthelot, expressed this idea when he declared that "if each of us adds something to the common domain in the field of science or art or morality, it is because a long series of generations have lived, worked, thought and suffered before us." This is another way of saying that our civilization, our knowledge, such mastery as we have attained have been built up step by step; that progress is essentially an evolutionary process.

We are told that in the beginning man was given dominion over the world, but it is only by very gradual stages that he has fitted himself to exercise that dominion. The power came slowly at first, and for many centuries was delayed. It is estimated that mankind has been on the earth five hundred thousand years, a period so long we can hardly comprehend it; and yet it is maintained that fully half the knowledge we have of nature and of control over it has come within the past hundred years. What has been achieved, even, affords only a glimpse of what may be accomplished through science and its teachings; and many equally revolutionary changes may be expected before this graduating class holds its twenty-fifth reunion.

A discovery rarely emerges full-fledged and complete in its potentiality and application. It is unfolded by degrees, often with but slight conception at first of its full significance. Sir Oliver Lodge recalls that Faraday's first magneto-electric machine, the forerunner of the dynamo, produced such insignificant results that a member of the Royal Institution, after a demonstration of it, asked what on earth was the use of it. A dignitary of the church, however, had a larger conception of its possibilities as a new tool in the hands of incendiaries, which led him to deplore the discovery. An apparently insignificant beginning may embody immense potentialities.

"We live forward, but we understand backwards," as a Danish thinker said. Knowledge comes before understanding or the application of it. We must know the forces and the conditions under which they operate before we can take advantage of them. What is discovered to-day can be used to-morrow. What we do not understand to-day we shall understand to-morrow, and it will help us to see and act more rationally.

Research is a study of relationships. One of the most important of these is that of man to the earth. His great struggle is not only to adapt himself to his environment, but to devise means by which he can make his environment subservient to him. This is what is being done to-day through the physical and biological sciences; and there are few more

striking applications of it than in the field of agriculture. That industry, which touches the lives and well-being of all the people at so many vital points, was late in receiving the benefits of science. This fact tended to make it backward and inefficient to a degree that led thinking people in Europe a century and a quarter ago to feel real concern for the future food supply of the growing population.

It was a gloomy view, but in keeping with the times and the prospect as then seen. For many hundred years man had been unable to increase greatly the yields of the principal crops. In fact, there had been practically no improvement in the agriculture of western Europe from the fall of the Roman Empire up to the close of the eighteenth century, when the Malthusian doctrine was announced. There had been little suggestion of the increase in productivity to be effected in food plants through breeding and selection, the stimulation of the soil by fertilizers and better handling, the more adequate return from farm animals and the increase of man's resourcefulness in a thousand ways.

The situation gives a striking background against which to project the remarkable changes which soon began to portend the new day of an efficient and enlightened agriculture. For the nineteenth century not only witnessed the greatest revolution in farm practice the world had known, but it ushered in the beginning of systematic research in agriculture, notably in agricultural chemistry, which gave new conceptions of the life of the plant and its relations to the earth. This was soon followed by the establishment of the experiment station, that powerful agency for applied science which has few counterparts, and which steadily has spread to every civilized country. The manifold results of the investigation thus stimulated have been felt by practically every branch and phase of agricultural production, not only, but have changed the attitude toward that industry. Its benefits have not been confined to the farming people, but have been shared in by other industries and by the people as a whole.

Understanding goes before improvement. As a first step toward a correct understanding of the plant and its environment, research dissolved the age-long mystery of how plants feed and how crops grow. The world waited long for such information, for it was scarcely a century ago that it became known. Gradually the plant was disclosed as a group of living factories, more wonderful than those made by man, drawing a part of their raw materials from the soil and much the larger part from the air, and from them elaborating a great multitude of different products.

This was an important starting point for determining what is essential and how improvement can be wrought. We no longer look upon the soil as a purely inert material but as one teeming with microscopic life which is influenced by tillage and in turn influences the process by which the plant gets raw materials from this source. We realize that the plant has to feed itself first, and then store up a reserve or surplus in tissues, seeds and other products, which man intercepts as return for cultivation. The greater the efficiency of the plant or crop as a factory for elaborating food or fiber or other desired materials, the more valuable it is for cultivation; and the provision of suitable soil and cultural conditions enables the plant to yield its largest return. It is this increase in efficiency of the crop, its quality or special adaptation and its favorable response to treatment that is the aim in plant breeding, culture, fertilizer and other experiments all along the way from seeding to harvest.

The proof that certain classes of plants, through partnership with nodules on their roots filled with bacteria, take up and use the nitrogen of the air in supplying the needs of growth was a great stride, an accomplishment in technique which has made every farmer more intelligent about the rôle of legumes.

Experimentation has given far more productive staple crops of higher quality, has introduced new crops for special purposes and greatly extended the area of successful farming in unfavored regions. Corn-growing, for example, has been pushed steadily northward more than three hundred miles beyond what was formerly believed to be possible. Fruit-growing is a profitable industry in many localities where formerly only the hardiest sorts could be grown. A new industry has been provided in the production of sugar from beets, and possibilities in that line developed which would make us independent of outside supply if necessity should require.

Science has given more appetizing and attractive food products prized by all—the perfect specimen of fruit, superior vegetables throughout the year, a greater variety and healthful preserved products. In fine, it has made more secure and satisfying the answer to the universal prayer to "give us this day our daily bread," by its constructive work in every branch of food production, including the improvement of cereals, their milling and baking.

Research does for the farm exactly what it does for the industrial plant—studies the operation at each step to see how it may be improved or made more economical, and measures the output of these natural factories to determine their efficiency. And it does more; it safeguards the output in another way.

For production is a continual contest; eternal

vigilance is its price, and that vigilance must be guided. The more intensive production becomes, the more severe the contest with diseases and pests, with the forces of evil against the powers of light. The farmer unaided is powerless to cope with these things until he has been shown. The specialist is required not only to diagnose a new trouble but to work out the mysteries of its life history and its relationships, the means by which it is propagated and spread, and determine its susceptibility to treatment. Left to itself the trouble means waste and destruction, possibly the ultimate discontinuance of that crop; studied by the expert, its successful control may mean only a slight change in cultural practice.

The working out of a mysterious destructive disease of potatoes whose cause could not be seen but only its effects, the means by which its death virus is spread from plant to plant by lice sucking the juices of the leaf they feed upon, and finally the demonstration that these invaders live over, not on the potato but on the rose bush, supplies an example of the deliberate, purposeful forging of a chain of evidence that is typical of constructive research, for it combined with imagination, perception and intelligent study the indomitable will to know.

Plant quarantine now checks the introduction of pests to prey upon our field crops, gardens, orchards and forests, albeit after hundreds of such pests unwittingly have been allowed to enter which reduce crop yields by more than a billion dollars a year. The setting up of such safeguards resulted from the teachings of research and supplies a type of prevention more mighty than cure—and far less costly.

After the food has been produced research stands guard over the quality of it until it reaches the consumer. This relates not only to freedom from adulteration but to wholesomeness of manufacture and healthfulness of the product. The provision of a supply of clean, wholesome milk the year around, free from the dangers of disease, is a benefit which reaches every family, and it is a notable result of agricultural investigation. Indeed the whole industry of dairying and dairy farming, the selection of more productive stock, the development of the silo and more rational feeding, and the manufacture of dairy products of all kinds has been revolutionized by agricultural research, to the great advantage not only of the farmer but likewise of those who enjoy a more uniform and higher quality of products. The same type of activity has disclosed the dangers and the channels of transmission through food of diseases like tuberculosis, with the result that neglect of known precautions has become a crime against society. It thus has an important relation to public health.

It may not be realized that the study of human food and nutrition in this country originated in the experiment stations, or that the work done there and in the national department of agriculture has been one of the chief means of bringing home the importance of proper nutrition and the basis for it. The subject of vitamines, for example, their sources and the malnutrition diseases, like rickets, scurvy and other troubles which result from their deficiency in the diet, has long been one in which the stations have taken a leading part. The bearing of these studies on the normal development of children in towns and cities is even more applicable than in the country.

The discovery that a disease of cattle in the southern states is transmitted by a tick and can be controlled by the elimination of that carrier may not have meant much to the people at large at the time, but it gave a wholly new conception of the spread of such dread diseases as yellow fever, malaria, typhus and others by insect carriers. Is it too much to claim this by-product of agricultural research as one of the most significant additions to medical science, making possible among other things such triumphs of sanitation as enabled the construction of the Panama Canal?

To realize the full importance of research in agriculture it is necessary to understand the part this industry plays in our business, our commerce and our well-being. Statistics are stupid things until interpreted to show what they mean. The fact that nearly twenty billion dollars worth of agricultural products a year are essential to the operation of leading manufacturing industries in this country may signify little beyond a figure incomprehensible to most of us. But when we learn that this amount comprises from one half to two thirds of the total value of raw materials entering into all manufactures, we see how indispensable agriculture is to these great industries.

Not only does manufacturing demand enormous quantities of agricultural products, but these must have special qualities to meet the need—a desirable hardness of wheat for milling; flavor, aroma and burning qualities in tobacco; size, attractiveness, uniformity and various other requirements of the trades. Agriculture is now remarkably responsive to these trade requirements, thanks to research. Is a long-fiber cotton needed—it is developed and adapted to growth in suitable locations; does change in the process of manufacture call for a shorter staple—strains are produced which combine with this quality a yield which enables the farmers to grow it; does the packing industry call for products of special

quality—experiments are made in the production of that quality on a commercial scale. The farmer as an individual producer would be wholly unable to supply such standardized products without the aid of investigation.

These things make clear the reciprocal interests of farming and manufacturing and the direct benefit of research to both lines. The great manufacturing state of Massachusetts, in addition to drawing its food very largely from sections quite remote, is dependent on agriculture outside its borders for most of its raw materials. Measured in value, considerably more than half the total output of its factories is manufactured from products of the soil. Its industries could not survive a single year without these supplies drawn from the south, the west and foreign lands, and the maintenance of both volume and quality is absolutely vital. Thus the benefits of agricultural research are not bounded by state lines; they are no less real to this commonwealth than in the regions where its raw materials are grown.

Research is itself a process of learning, but not all centers of teaching are likewise centers for enlarging the field of knowledge. A conspicuous feature of the group of institutions to which this one belongs is that they are fulfiling the double mission of centers of teaching and agencies for learning. It is this that has made them truly democratic—not merely for the few who come to their halls, but for all who will take advantage of the practical results of their research spread broadcast.

The people of this country have built up the most comprehensive and effective system for agricultural research to be found anywhere, represented by the federal department of agriculture and the state experiment stations. The station system started in Connecticut fifty years ago, with an appropriation of less than $3,000, and it is interesting to note that plans are under way for a national observance of this important anniversary at New Haven a few months hence.

In the development which has taken place in the half century, the New England states have had a leading place, noticeably so in the earlier stages. The names of Atwater, Johnson and Jenkins in Connecticut and of Jordan in Maine will stand out as pioneers who supplied ideals on which the American stations rest; while our own Goessmann, Fernald and Brooks will be remembered with great honor for their notable contributions which led the way in channels that were new.

From these small beginnings the experiment stations have grown to a national system, with an aggregate maintenance fund of $10,000,000 a year, equivalent to the income from an endowment of $200,000,000—this for a twenty-five billion dollar industry from which half the entire business of the country, half the tonnage value of the railroads and a large share of the commerce arise. To-day these stations, with the federal department of agriculture, constitute one of the most powerful agencies for the benefit of human welfare in any line.

If some great aggregation of wealth should announce the provision of an endowment of $200,000,000 for research, it would call for the largest type the newspapers had and would be heralded as a great benefaction. Such an endowment would be a remarkable tribute to the appreciation of this type of service—and it is, the more so because it expresses the judgment of the people in forty-eight states. The latest congressional measure, to go into effect next month, came as a response for relief of the agricultural industry. It is a great endorsement, for it represents the mature judgment that agricultural prosperity can not be assured through special legislation, but that safe advancement must rely on sound knowledge of scientific and economic principles to be worked out through research.

Out over the country, stretching from this eastern boundary to the Pacific and beyond, is a small army of zealous, faithful workers spending their lives in research for agriculture—for the benefit of the consumers as well as the producers in that field. They represent an infinitesimal proportion of those to whom their labors mean very much. Many of them have come from this institution. They are a product in which to take genuine pride. They have helped to make agriculture what it is, and they look forward to increasing usefulness. For they are builders of vision, the men who can!

We glory in the man who can;
We glory in his might and mastery.
We glory that within the sullen clod
His eyes have read the secrets of our God;
That his own hands have grappled with the key
For fellowmen to set those secrets free.
We glory of his deeds to tell;
And it is well.

E. W. ALLEN
U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

RESEARCHES ON INSULIN[1]

I. IS INSULIN AN UNSTABLE SULPHUR COMPOUND?

IN the early autumn of 1924 we were invited by Professor A. A. Noyes, director of the Gates Chem-

[1] From the Gates Chemical Laboratory, California Institute of Technology, Pasadena, California. Carried out under a grant from the Carnegie Foundation.

ical Laboratory of the California Institute of Technology, Pasadena, California, to investigate the chemical and other properties of insulin in his laboratory under a grant from the Carnegie Foundation. Commercial insulin as prepared by the Lilly Research Laboratories of Eli Lilly and Company, Indianapolis, Indiana, has served as the material for our investigation. Two forms of commercial insulin have been used by us; one a dry powder evaluated at approximately 8 rabbit units per milligram; the second a highly concentrated aqueous solution (2.44 per cent. solids) containing approximately 300 rabbit units per cubic centimeter, and with 120 milligrams of hydrochloric acid per 100 cubic centimeters.

The usual methods of fractioning and purifying bodies of protein or proteose nature have been of no service in purifying this commercial insulin, which has already been submitted to four or five isoelectric precipitations. Salting out with ammonium sulphate or sodium chloride, precipitation with tannic acid in the presence of electrolytes or precipitation with any one of a long list of metallic compounds, with phosphotungstic, phosphomolybdic or picrolonic acid, to name only a few of the many reagents that have been employed, throws down practically all the constituents of the commercial insulin and leaves only an insignificant residue of inactive material, consisting almost entirely of inorganic matter. And yet it is easily demonstrated that the above commercial insulin, even the one containing 12 rabbit units to the milligram, is a mixture of many different compounds. The details of our procedures will be found in a recent number of the *Journal of Pharmacology and Experimental Therapeutics*, 1925, XXV, No. 6, p. 423.

Neglecting inorganic constituents, we have separated from this iletin crystalline amino acids, protein-like fractions of varying sulphur content and low phosphorus content, and such as have a medium or relatively low sulphur content and a high phosphorus content. All these fractions have either no or only relatively little insulin-like action and all of them, no doubt, are capable of further differentiation. The insulin becomes concentrated in one particular fraction (fraction IV). The active insulin can be almost completely removed from all the others. These separations have been effected by the use of simple and non-injurious methods. In the course of the purification the insulin rabbit unitage was raised from 8 and 12 to more than 40. We regard our purified preparations (fraction IV) with the high unitage only as excellent material for further fractionation, and additional data on this point will appear later. We possess many data in regard to several reactions of the active preparations (as the ninhydrin reaction, for example) which we prefer to present, after more study, in a subsequent paper for the reason that some uncertainty always attaches to such data as long as the chemical individuality of the principle in question has not definitely been established with certainty. We are, however, making an exception in giving thus early our findings in respect to the highly unstable sulphur of our active preparations and its relation to the hormone, insulin, present. We have found that when an "insulin" of relatively high unitage is boiled for a short time with N/10 Na_2CO_3, the resulting physiological inactivation is always associated with an alteration in the linkage of a part if not all of the sulphur that properly belongs to the hormone. *After such treatment with an alkali a new property appears in the altered insulin in that it shows extraordinary sensitivity to very dilute acids which now liberate hydrogen sulphide from it.* Previous to this alkaline treatment these same acids applied in greater concentration and with heat fail to evolve even a trace of hydrogen sulphide from insulin. We have lately observed that boiling an insulin preparation with very much weaker alkali than N/10 Na_2CO_3 still produces the above described alteration in the linkage of its sulphur.

While crude insulin always liberates ammonia on being boiled with a dilute solution of sodium carbonate, in consequence of the destruction of certain amino acids still present in it, our purified preparations of relatively high unitage evolve no ammonia when similarly treated. We have also found that our insulin preparations of a unitage 40,[2] are more sensitive to boiling with weak acids (N/10 to N/15 H_2SO_4) than was supposed by previous investigators who worked with cruder products. We have very recently observed that neither ammonia nor CO_2 is removed from the insulin by such treatment, and at the moment we are endeavoring to learn just what changes in insulin fractions of even higher unitage are associated with its inactivation at the lowest hydrogen-ion concentration at which the inactivation can be effected. Phosphorus is not a constituent of insulin, as has been maintained by Ganassini and Gerbino, who have gone so far as to assert that the quantity of phosphorus in insulin prepared in different ways was always strictly proportional to the degree of physiological activity.

It was found that our inert fractions contain very little of the labile sulphur, referred to above, *and that in all fractions the content of labile sulphur, more especially what we have called the "sodium carbonate*

[2] Our unit is that fraction of a milligram of insulin per kilogram of rabbit which will reduce the blood sugar to the convulsive level or produce a convulsion.

sulphur," appears to be directly proportional to the degree of hypoglycemic activity. In other words, the higher the amount of sodium carbonate sulphur present in a given preparation the greater is its potency. In our paper above referred to will be found a table of chemical analyses and biological measurements in proof of our statement that the hypoglycemic activity of insulin goes hand in hand with the amount of easily split-off sulphur. Another point worthy of notice is that the total sulphur of an insulin preparation also rises with increasing purification.

It has been known for some time that insulin is readily inactivated by alkali and that even boiling for ten to fifteen minutes with so weak an alkali as N/10 Na_2CO_3 suffices to deprive an insulin preparation entirely of its sugar-lowering property. But it has not hitherto been shown that an alteration in the affinities of the element sulphur occurs coincidentally with this inactivation. Is there a causal connection between the chemical and biological events? The results of our work lead us to believe that this unstable sulphur is an integral part of the insulin molecule and that the alteration in its condition consequent upon heating with sodium carbonate bears to the destruction of the physiological activity of the hormone the relation of cause to effect.

It is not our purpose at this time to discuss the mode of action of insulin, but we do, however, wish to point out that if the labile sulphur is a pivotal element of insulin, then we possess in it a sulphur compound of high specificity, and one that plays a paramount rôle in the normal metabolic changes which the carbohydrates undergo during their utilization in the animal economy. In this connection, too, the question suggests itself as to what extent, if any, the islets of Langerhans are dependent upon the presence in our food of a special labile sulphur compound, a precursor indispensable for the elaboration of the hormone, in the absence of an adequate supply of which pathological alterations in the cells of the islets of Langerhans would take place. Should a connection of this nature be ultimately established, there would come to light an important and hitherto unrecognized etiological factor in the causation of diabetes mellitus.

Up to the present it was not possible to give an explanation of the mechanism of the physiological inactivation of insulin by weak alkalis. Our findings seem to us to correlate for the first time certain chemical properties of insulin, more especially the hitherto unsuspected extreme lability of its sulphur, with its biological activity, and we hope that our observations may serve as the basis of a method for the chemical assay of the hormone—a method of assay which is urgently needed as an adjuvant, if not as a substitute for the present costly, time-consuming and unsatisfactory rabbit method. The action of very dilute acids at various temperatures upon highly purified preparations of insulin will also lead to the discovery, we hope, of chemical methods for evaluation.

It is now only a matter of time, we believe, when this unstable hormone must yield to the investigator the secrets of its composition and the rationale of its operations within the body. A host of investigators have already made many significant and valuable contributions in reference to the influence of insulin upon the various stages of carbohydrate metabolism, but an explanation of the biochemical mechanism involved in the action of the hormone (at strategic points and moments, so to speak) must wait upon the more definite information along chemical lines such as that referred to above.

JOHN J. ABEL,
E. M. K. GEILING,
G. ALLES,
A. RAYMOND

EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE REVILLAGIGEDO ISLANDS

As already announced in SCIENCE (issue of April 3, 1925), the California Academy of Sciences recently sent an expedition to the Revillagigedo Islands for the purpose of studying their fauna, flora and geology. The Secretary of the Navy detailed the U. S. S. *Ortolan* for the purpose, and the expedition sailed on April 15 from Mare Island Navy Yard.

On the way south the *Ortolan* touched at San Diego to receive on board three Mexican biologists, whom the California Academy of Sciences had invited to be its guests on the cruise. They are Professor Francisco Contreras, director of the National Museum of Mexico, Dr. Octavio Solis, director of the Botanical Garden at Chapultepec, and Professor José Maria Gallegos, chief of botanical explorations, National Museum of Mexico.

From San Diego the expedition proceeded to Guadalupe Island, which lies about 180 miles to the southward, thence to Alijos Rocks, about 200 miles further south. Large and valuable collections were made at each of these stations.

From Alijos Rocks the vessel proceeded direct to Clarion, the most westerly of the Revillagigedo group, where several days were spent making collections. The other islands of the group—Roca Partida, Socorro and San Benedicto—were then visited in turn, and as

thoroughly explored as time and facilities would permit.

Dr. Hanna, who is in charge of the expedition, sends in by wireless to the academy weekly reports of the progress of the work. These reports indicate that the expedition so far has been very successful and that excellent collections of birds, fishes, reptiles, plants and in other groups have already been secured.

From the Revillagigedos the expedition went to the Tres Marias Islands, near Mazatlan, where it is now (May 23) engaged in biological studies. From the Tres Marias the *Ortolan* will proceed northward, stopping at a number of places in Lower California, and reaching San Francisco on or about June 22.

The Revillagigedos are a little known and rarely visited group, consisting of five volcanic islands varying in size from Socorro, which is about 100 square miles in extent, to Oneal Rock, which is little more than a menace to navigation. The others are Clarion, San Benedicto and Roca Partida. Much of the coast of these islands is "iron-bound," and, viewed from the sea, is very picturesque. Pounding waves hammer out caves and arches from the faces of the cliffs, and, in so doing, shatter themselves into cascades of foam. Harbors are few, not too well defined and afford protection according to their position and the direction of the seasonal winds. Even within the harbors the heavy surf makes landings in small boats difficult, save in the calmest weather.

These islands are so poorly provided with natural attractions that the obstacles to landing seem unnecessary. Aside from the rather heavy growth on the weather side of Socorro, the red soil supports but a scanty vegetation. An abundance of cacti and hooked awns seems to exist for the discomfiture of humans, and beds of broken lava and hills of volcanic ash form almost insuperable barriers to cross-country traveling.

Unattractive as these islands appear to man, they are, nevertheless, the paradise of myriads of sea birds. Insular forms of land birds, reptiles, mollusks and plants also occur here. Seal rookeries apparently existed—perhaps still do—on Socorro and San Benedicto. The surrounding seas teem with fish and reports of numbers of whales accompanied by young bear witness to a breeding ground in the vicinity. Indeed, a certain ocean area not far distant is known as the "cow pasture."

Because of the peculiarities in the biota, the Revillagigedos are of special interest to naturalists, and repeated visits have been made for the purpose of obtaining specimens of their animals and plants. The history of these expeditions is punctuated by accounts of wrecked vessels, swamped boats, hairbreadth escapes and lost collections. Each disaster, however, has but proved an incentive for a fresh undertaking.

Although the group was discovered by Hernando de Guxalvo in 1533, the natural history seems to have received little attention until Captain James Colnett visited the Pacific coast in the interest of the whale fisheries. In September, 1793, he reached the first island of the group which he named in honor of the Mexican viceroy, Revillagigedo. With a view to making "Socorro" more than a meaningless name, Colnett's first step was to have European garden seeds and sprouted cocoanuts planted there. Apparently this move in nowise upset the balance of nature, for upon his return to the island three months later the nuts had decayed and there was no sign of sprouted seeds. Colnett made no attempt to visit the interior of Socorro, but assumed the existence of a freshwater lake in the hinterland, because of the number of teal seen in flight. The presence of other species of birds was noted, and the insects, mollusks, reptiles and crustaceans commented upon. Fish were reported to be numerous, but few could be obtained for food because of the voracity of the sharks.

In the course of a voyage in the service of a New England trading firm, Captain Benjamin Morrell called at Socorro in May, 1825. His stay was brief, but sufficiently long for him to take a census of the pinnipeds on the island.

The *Sulphur,* and her consort the *Starling,* made serious attempts in 1837 and 1839 to check the positions of the various islands and to eliminate from the charts names of some that were non-existent; for, in the course of time, this group of four islands and attendant rocks had grown into two groups, each comprising more islands than the whole archipelago possessed. These errors are not entirely a thing of the past, as maps of quite recent date bear the names of wholly mythical islands. A few specimens also were added to the natural history collections that had been made elsewhere.

The bird life of the Revillagigedos was first seriously studied by Colonel Andrew Jackson Grayson, who paid two visits to Socorro, the first in 1865, the second in 1867. Shortage of provisions curtailed his first stay, and his plans for the second were wrecked with the vessel upon which he came. During his second visit he was able to add considerably to the number of specimens he had previously secured before the arrival of a rescue ship. The difficulties experienced in embarking, however, forced Grayson to leave behind all his collections except the bird skins, one land shell and one lizard.

The abundance of fishes in the adjacent seas had attracted the attention of all visitors to the group, but Lieutenant Henry E. Nichols, of the *Hassler,* was the first to make a collection. In 1880 he visited both

Clarion and Socorro and secured twelve specimens comprising nine new species.

The six days of the 1888–89 cruise of the *Albatross*, allocated to the work in these islands, was sufficient to permit calls at Clarion, Socorro and San Benedicto. From each of the islands interesting collections of birds, reptiles, plants, mollusks, fishes and insects were secured by Dr. Charles H. Gilbert, the naturalist on the *Albatross*.

In 1897 Mr. A. W. Anthony greatly increased our knowledge of the bird life of the group. During the three weeks he devoted to the work, large collections of birds were made, and some invertebrates and plants taken.

The Webster-Harris expedition, of which Lord Rothschild was the moving spirit, made a brief call at Clarion in 1897 and obtained small series of birds, reptiles and insects.

The first expedition sent by the California Academy of Sciences to the Revillagigedos spent seven weeks in 1903 in making a survey of the islands. Collections of birds, fishes, reptiles, insects, mollusks and plants were made, but they were destroyed in the earthquake and fire of 1906 before the mass of the material had been studied. Members of this party were apparently the first to reach the summit of Socorro. Evidence pointed to volcanic activity in the not too distant past, as many hot springs were discovered near the peak.

The expedition sent to the Galapagos Islands by the California Academy of Sciences in 1905 called at San Benedicto, Socorro and Oneal Rock, securing a few specimens from each.

In 1916 the tuna investigations conducted by the U. S. Bureau of Fisheries took the *Albatross* into those waters. The small collections of sea birds and invertebrates obtained were turned over to the California Academy of Sciences.

It is now hoped that, with the facilities at its command, the *Ortolan* expedition will obtain the material needed to fill the gaps in the existing collections and so make possible a thorough understanding of the natural history and faunal relations of the Revillagigedo Islands.

MARY E. MCLELLAN
CALIFORNIA ACADEMY OF SCIENCES

SCIENTIFIC EVENTS

THE TWO HUNDREDTH ANNIVERSARY OF THE RUSSIAN ACADEMY OF SCIENCES

THE Russian Academy of Sciences at Leningrad, founded at the end of the reign of Peter the Great, has completed its program for the celebration of its two hundredth jubilee anniversary in September. Prominent scientific men from a score of countries will attend. The program, extending from September 5 to 14, includes sessions at both Leningrad and Moscow, gala performances of the opera in Leningrad and of the Moscow Art Theater in Moscow, banquets tendered to the visitors by both cities and a state breakfast in the Kremlin. Leading American universities and scientific societies have been invited to send representatives.

A statement in regard to the academy sent SCIENCE from the New York Bureau of the Russian Telegraph Agency reads:

> The academy was originally founded by Peter the Great in 1725. It was the Russian expression of the general scientific development of the eighteenth century, particularly in physics and mathematics. The German philosopher and mathematician Leibnitz drew up its constitution. Other German scientists organized various departments of research. In its early days its greatest contribution was in geography. It explored and charted immenses stretches of territory in Russia. During the nineteenth century the academy's work won the esteem of west European scientists, who invited the Russian academy to join the International Association of Academies.
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> Until the revolution, the Russian academy was dominated by the Czar and the nobility. It suffered from the general lack of system characteristic of Czarist Russia. Attempts to systematize its work were begun in 1912, but were interrupted by the war.
>
> The chaos which attended the Russian civil wars wrought great hardships on the scientists. They were exposed to cold and famine. They had no means for carrying on research, publishing books and magazines or taking care of institutions. The laboratories were deserted for lack of fuel. However, the defeat of the counter-revolution and the raising of the allied blockade enabled the Soviet Government to come to the assistance of the scientists. Early in 1921 a deputation from the academy visited Lenine and laid the situation before him. Subsequently the Soviet Government appropriated money for the restoration and extension of scientific work.
>
> The academy has since then restored libraries, collections and museums disturbed or neglected during the civil war. The academy's library, which before the war contained 3,000,000 volumes, has been increased to 4,500,000 volumes. The collections of the zoological, ethnographic, mineralogical and Asiatic museums have been increased to such an extent that the Soviet Government has had to enlarge their headquarters, making special appropriations for equipment and repairs.
>
> With this assistance the Russian Academy of Science has been able to convert the old physics laboratory into the Physico-Mathematical Institute, with special workshops for making precise instruments. Most of the museums have been doubled or trebled in size. The seismographic station, at Pulkovo, which burned down in 1920, has been replaced by a new one. The chief Russian seismographic stations have been restored and contact established with seismographic stations throughout the world.

The great strides made by the Russian academy since the revolution and the improvement of general economic conditions is indicated in its report for 1924. During that year the academy held 64 meetings at which 112 papers were read discussing 85 important questions. Four hundred additional papers were read at meetings of different sections of the academy. In addition, the academy published 55 scientific books, copies of which were sent abroad; and 78 expeditions were sent to the Urals, Siberia, Mongolia, Central Asia, North and South Russia, etc. The physiological laboratory carried on research on the occipital lobes of the higher animals. Other departments prepared a catalogue on the life, culture, social structure and religions of India; and studied the biochemical properties of human blood. Important work was also done by the Asiatic museum which prepared for publication 340 volumes of Dao-Jsan and other Chinese works.

The academy has also stimulated an interest in applied science. Researches and experiments have been carried on in the separation of metals by nitrogen under high temperature and pressure; Crimean lakesal has been analyzed; and a new system of making seismographs has been invented.

The academy works in close cooperation with economic organizations and with the government. It has prepared maps and other material for the government and is working with the State Planning Commission on a study of Russian natural resources. Other government commissions with which the academy cooperates are conducting studies in race problems, tropical countries, the Polar regions, literature, dictionaries and bibliographies.

Important are Professor Steklov's studies in the basic problems of mathematical physics; Professor Numerov's astronomical studies; Professor Joffe's studies on the atomic structure of matter, and Professor Pavlov's studies in biology and pathology.

The academy has already reestablished many of its contacts with scientists of other countries. Charles D. Walcott, of the Smithsonian Institution of Washington, D. C.; Fridjof Nansen, of Norway; A. J. Thompson, of England, and scientists of various other countries are honorary members of the academy. Among the academy's corresponding members are Dr. Alexis Carrel, of New York, and Professor A. A. Michelson, of the University of Chicago; Louis Bauer, of Washington, D. C.; Madame Curie and Albert Einstein.

THE DORMITORIES OF THE HARVARD MEDICAL SCHOOL

MR. HAROLD S. VANDERBILT, of New York City, has given to the Harvard University Medical School for the new dormitories the sum of $575,000, in addition to the $125,000 that he gave last April for the installation of a gymnasium within the dormitories. Since the latest architects' estimate of the total cost of the land and buildings is $1,327,865, and since the building fund now has $445,000 and expects a contribution of $300,000 from the Harvard corporation, Mr. Vanderbilt's gift will permit immediate construction of this much-needed addition to the Medical School, with the entire expense provided for in advance. The plan to provide a special dormitory for the Harvard Medical School was first undertaken as long ago as September, 1923. Since that time subscriptions have been raised in the following amounts from the following sources:

1,486 doctors	$112,984
594 lay donors	207,026
Expected from Harvard University	300,000
Total	$620,010

The new dormitory will provide housing for 250 men, who are now occupying often unsuitable quarters in scattered sections of Boston and Cambridge. A dining hall will be included, which will be convertible into a medical auditorium. Here it is expected that physicians can be seen and heard by students, faculty, profession and public, and the larger medical societies may hold their future annual assemblies.

Moreover, it has been found that the regular weekly lectures given under the auspices of the school to the public at large have outgrown the present amphitheaters in the medical school, which accommodate only about 300. The large auditorium in the new dormitory will be available for the lectures hereafter.

Plans for the new building have been drawn by Coolidge, Shepley, Bulfinch & Abbott. Although these may be the final plans, the critical study and analysis of them has yet to be completed by the fund committee, by Dr. David L. Edsall, dean of the Harvard Medical School, and by other authorities.

HONORARY DEGREES CONFERRED BY THE UNIVERSITY OF CAMBRIDGE

As has already been reported in SCIENCE, the University of Cambridge, in connection with the meeting at Cambridge of the International Astronomical Union, conferred the honorary degree of doctor of science upon five leading members of the union. The ceremony took place in the Senate House on July 21, the vice-chancellor, Dr. A. C. Seward, master of Downing, presiding.

In presenting a general greeting to the astronomers, the public orator, Mr. T. R. Glover, as reported in the London *Times*, reminded them that they had come to the university of Newton, and further, he referred to the discussion between Adam and the Archangel in "Paradise Lost," turning upon the very problems to which the astronomers were giving their lives. He quoted in the version of "Gulielmus Hogaeus" (William Hog) the lines of the Archangel: "With centric and eccentric scribbled o'er." The Archangel, he said, was very properly on the side of eternity and willing

to weigh the simpler theories of Copernicus. Satan, lover of the fugitive and the temporary, was a firm adherent of the old and false. The orator believed that the astronomers were "on the side of the angels."

In presenting President Campbell, of the University of California, the orator, speaking in Latin, said that there was on a mountain top a building—he himself had seen it from afar—where for five and twenty years, amid the solitudes, sat a philosopher for whom "the moon, day, night and all night's stars austere," brought many a dark and difficult question, for which, however, as far as a man amid the things of God could be, he was equal. But he was recalled from the mountains to preside over a great university with 9,000 students of both sexes. There was no bay, the public orator thought, in the world that outshone the Bay of San Francisco, within its Golden Gate. So did it delight one with the alternate charms of sun and sea mist, with the beauty of tree and hill, that he might well believe that Homer himself, when he described the Isles of the Blest in the West, free of the snow and tempest, glad in zephyr and the ether, happy in that gathering of white souls, was really describing this place which the orator found as delightful as he did. He was delighted, as a conscript in the company of the Golden Bear, to present to them his friend, President William Wallace Campbell.

In presenting Professor W. de Sitter, the orator said he was in charge of the observatory at Leyden. He counted Jove and the four Galilean satellites as Jove among his intimates, as might be expected of one who had so long wooed Jove's daughter Truth in South Africa. They would remember the words of the Athenian: "Vortex reigns," but Newton taught men not to believe too much in Aristophanes or Descartes. Contemplating the incredible mechanism of nature, Newton repudiated Vortex and its arbitrary rule. He found order in the heavens, and this their guest further elaborated. But lately it had been whispered among shrewder people that Newton had been abandoned for relativity, and on that subject the orator did not know what to say to their guest.

Introducing Dr. B. Baillaud, the Public Orator said that when first the astronomers met in this conference M. Baillaud was their chairman. Since then he had made the Eiffel Tower a center of a network of wireless for the more accurate keeping of time. He was among those at the head of French astronomical research. Amid the flames of war, while from afar Long Bertha hurled every day her globes of fire at Paris, their friend never abandoned his station, but while earth blazed, like Archimedes, he was at leisure for the society of the stars, and, as if in peace, had his mind on the things of heaven—a true philosopher.

In introducing Professor Nagaoka, the Public Orator said light was once more sought from the East, and a Japanese astronomer came well skilled to track the footsteps of the fugitive atom. A shrewd and able investigator, he had quite recently invited the men of science to decide whether in point of fact he really had made gold out of humbler atoms by transmutation.

In introducing Dr. Schlesinger, he said their guest, a true "son of Eli," was eminent among those who had tried to measure the distance between the stars. Whether, with Bacon, they called it "perspicillum," or, with Milton, "a glazed optic tube," he was taking one from New England to South Africa that, after the study of another sky and other stars, he might still further blend light and truth.

COMMITTEES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

AT the first meeting of the board of directors of the American Institute of Electrical Engineers for the administrative year beginning August 1, 1925, held in New York on Thursday, August 6, President Pupin announced the committee appointments as follows:

GENERAL COMMITTEES

Board of Examiners.—Erich Hausmann, Brooklyn, N. Y.

Finance.—G. L. Knight, Brooklyn, N. Y.

Sections.—Harold B. Smith, Worcester, Mass.

Meetings and Papers.—E. B. Meyer, Newark.

Publications.—L. F. Morehouse, New York.

Coordination of Institute Activities.—Farley Osgood, Newark.

Student Branches.—C. E. Magnusson, Seattle.

Membership.—J. L. Woodress, St. Louis.

Headquarters.—H. A. Kidder, New York.

Law.—W. I. Slichter, New York.

Public Policy.—Gano Dunn, New York.

Code of Principles of Professional Conduct.—John W. Lieb, New York.

Safety Codes.—Paul Spencer, Philadelphia.

Standards.—H. S. Osborne, New York.

Edison Medal.—Gano Dunn, New York.

Institute Prizes.—L. W. W. Morrow, New York.

Columbia University Scholarships.—W. I. Slichter, New York.

Licensing of Engineers.—Francis Blossom, New York.

TECHNICAL COMMITTEES

Electrical Machinery.—H. M. Hobart, Schenectady, N. Y.

Power Generation.—V. E. Alden, Baltimore.

Power Transmission and Distribution.—Percy H. Thomas, New York.

General Power Applications.—A. M. MacCutcheon, Cleveland.

Applications to Marine Work.—L. C. Brooks, Quincy, Mass.

Applications to Mining Work.—F. L. Stone, Schenectady, N. Y.

Applications to Iron and Steel Production.—F. B. Crosby, Worcester, Mass.

Electrochemistry and Electrometallurgy.—G. W. Vinal, Washington, D. C.

Production and Application of Light.—P. S. Millar, New York.

Communication.—H. P. Charlesworth, New York.

Instruments and Measurements.—A. E. Knowlton, New Haven.

Protective Devices.—E. C. Stone, Pittsburgh.

Electrophysics.—J. H. Morecroft, New York.

Education.—Harold Pender, Philadelphia.

Research.—J. B. Whitehead, Baltimore.

The board of directors confirmed the appointment by President Pupin of new members of the Edison medal committee for terms of five years each as follows: George Gibbs, New York; Samuel Insull, Chicago; R. D. Mershon, New York. The board also elected three of its membership as members of the Edison medal committee for terms of two years each, namely: W. P. Dobson, Toronto; Farley Osgood, Newark, and A. G. Pierce, Cleveland.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the graduation ceremonial of the University of Edinburgh, on July 25, the honorary doctorate of laws was conferred on Professor A. S. Eddington, Plumian professor of astronomy and natural philosophy in the University of Cambridge.

FOREIGN members of the Linnean Society of London have been elected as follows: Dr. Nathaniel Lord Britton, director-in-chief of the New York Botanical Garden; Professor Carl Schroeter, of Zürich, and Dr. Alexander Zahlbruckner, director of the department of botany of the Natural History Museum in Vienna.

DR. HENRY F. OSBORN has been appointed chairman of the Mary Clark Thompson Fund of the National Academy of Sciences in succession to Dr. Charles D. Walcott. Professor W. B. Scott has been appointed a member of the committee.

DR. LEOPOLD VACCARO, an instructor in the Medical School of the University of Pennsylvania, who is in Rome in the interests of the Philadelphia Sesqui-Centennial Exposition, has received the honorary degree of doctor of medicine from the University of Rome.

DR. SERGE VORONOFF, director of the laboratory of experimental surgery in the Collège de France, has been named Chevalier of the Legion of Honor.

AFTER forty-seven years' uninterrupted work Professor Charles Richet, the physiologist, of Paris, recently delivered his last lecture in the presence of the dean of the faculty of medicine and a large audience of professors and students.

DR. DAVID J. DAVIS, professor of pathology and bacteriology in the Medical School of the University of Illinois, has been appointed to the newly established position of director of research in the Research and Educational Hospital.

EDWIN R. MARTIN, assistant professor of electric power engineering at the University of Minnesota, has resigned in order to take a position in the industrial power division of the Westinghouse Electric and Manufacturing Company at East Pittsburgh.

D. J. PRICE, engineer in charge of development work in the Bureau of Chemistry, Department of Agriculture, has resigned to take up commercial work in Pittsburgh. In accepting Mr. Price's resignation, Dr. C. A. Browne, chief of the Bureau of Chemistry, wrote: "The investigational work upon dust explosions, which you have initiated and directed since becoming associated with the Bureau of Chemistry in 1914, has resulted in the prevention of enormous economic losses in various agricultural industries."

Nature reports that Sir Ernest and Lady Rutherford left Great Britain for Australia and New Zealand on July 25 on the S. S. *Ascanius*, bound for Adelaide. While their main object is to visit their parents and relatives in New Zealand, Sir Ernest has also promised to deliver lectures on aspects of modern physics in some of the chief cities of Australia and New Zealand. They hope to return to England in January, 1926.

DR. CHARLES B. DAVENPORT attended the seventh meeting of the International Commission of Eugenics which was held in London on July 14 and 15.

DR. JOHN A. MILLER, who will lead the expedition of the Sproul Observatory of Swarthmore College, to observe the total solar eclipse of January, 1927, is now in the Orient to make preliminary arrangements.

PROFESSOR H. E. ROSE, of the dairy department of the State College of Agriculture at Cornell University, has accepted the invitation of the government of Argentina to investigate and report on conditions in the dairy industry of the country. Dr. Rose and his family sailed for South America on August 15.

DR. WILHELM MARINELLI, assistant of the II Zoological Institute of the University of Vienna, Austria, has been working in the division of mammals of the U. S. National Museum, studying the skulls of carnivores. Dr. Marinelli expects to be in the United

States from six to twelve months and will visit the principal museums of the country in that time.

DR. BRUNON A. NOWALKOWSKI, professor in the State School of Hygiene, Warsaw, Poland, and a fellow of the International Health Board of the Rockefeller Foundation, who spent last year at the Johns Hopkins University, will study the coming year at Harvard University.

A LETTER from Dr. Hrdlička dated July 14 at Adelaide, Australia, reports that he has taken measurements of many aborigines and of over 1,000 skulls. He reports the heartiest cooperation on the part of scientific men in the museums, the Australian government officials, and from the U. S. Consular officers.

ON July 27 Mr. Samuel G. Gordon, assistant curator of minerals of the Academy of Natural Science of Philadelphia, returned from a six months' trip to Bolivia and Chile. Thirty-eight cases of mineral specimens were secured. This is the third of the academy's mineralogical expeditions, the first having been to the Andes in 1921, and the second to southern Greenland in 1923.

DR. PAUL BARTSCH, of the Smithsonian Institution, has left for Tortugas, Florida, where he will spend a month in the study of heredity among the Cerions.

DR. H. M. JOHNSON, formerly assistant professor of psychology at Ohio State University, has accepted an industrial fellowship at the Mellon Institute of Industrial Research of the University of Pittsburgh, where he will conduct an investigation of the psychological and physiological aspects of sleep. Owen W. Ellis, formerly assistant professor of metallurgy at the University of Toronto, Harold K. Work and Isaac H. Odell, Jr., of Columbia University, are among other recent appointees as industrial fellows.

IT is announced in *Nature* that at the annual general meeting of the Royal Society of New South Wales, held on May 6, the following officers were elected: *President,* Professor R. D. Watt; *Vice-presidents,* Mr. J. Nangle, Mr. E. C. Andrews, Mr. C. A. Sussmilch and Dr. C. Anderson; *Treasurer,* Professor H. G. Chapman; *Secretaries,* Mr. R. H. Cambage and Dr. R. Greig-Smith.

THE British Institution of Electrical Engineers has elected the following officers: *President,* Mr. R. A. Chattock; *Vice-presidents,* Lieut.-Col. K. Edgcumbe, Professor W. M. Thornton; *Treasurer,* Mr. P. D. Tuckett.

THE *Journal* of the American Medical Association writes: "Mme. Curie, the discoverer of radium, has recently visited Czechoslovakia as the guest of the Czechoslovak government on her return to Paris from her native country, Poland. For the first time she saw the places from which the ore was brought, from which she succeeded finally in isolating radium. She visited, in Prague, the State Institute for the Study of Radium and the clinic of Professor R. Jedlička for the study of medical radiology. Accompanied by former pupils from her Paris laboratory, Mme. Curie visited also the watering place Jachymov, where she descended into the mine from which the ore was taken to be shipped to her Paris laboratory. Her chief interest was centered on the presence in the Jachymov ores of ionium, which she is studying at present and from which she expects further advances in the treatment of malignant growths because she anticipates that with ionium it will be possible to develop a more prolonged and moderate treatment than has been possible with radium.

DR. WILLIAM W. GRAVES, professor and director of the department of mental and nervous diseases of the St. Louis University School of Medicine, has been invited to deliver a lecture under the auspices of the William Ramsay Henderson Trust in the University of Edinburgh on October 16. The subject will be "The relations of shoulder-blade types to problems of mental and physical adaptability."

DR. SELIG HECHT, at present in Europe as fellow of the International Education Board, delivered recently two lectures on the "Photochemistry of vision" at the Kaiser-Wilhelm Institute in Dahlem and at the Physiological Society in Berlin.

THE widow of the late George M. Sternberg, at one time Surgeon General of the United States Army, has donated to the University of Michigan Medical School a sum of money, the interest of which is to be used for a medal to be awarded to the student who during his course has made the best record in preventive medicine.

DR. FRANCIS ROBERT JAPP, F.R.S., emeritus professor of chemistry in the University of Aberdeen, died on August 1.

DR. RUDOLF MARTIN, professor of physical anthropology in the University of Munich, died on July 11 at the age of sixty-one years.

A SPECIAL cable to the New York *Times* reports the murder of Professor Felix Rosen, professor of botany and director of the institute of plant physiology in the University of Breslau. Dr. Rosen was sixty-two years old.

THE Swedish meteorologist, Ernest Calwagen, was

instantly killed on August 11 when a plane in which he was making observations for the Norwegian Meteorological Institute fell from a high altitude.

A JOINT meeting of ten sections of the American Chemical Society will be held in New York City during the week of September 28 to October 3. The sections cooperating in this meeting are New York, Western New York, Eastern New York, Rochester, Ithaca, New Haven, South Jersey, Lehigh Valley, Pennsylvania State College and Philadelphia Sections. Arrangements have been made for reduced rates over the railroads for members of the society from points in New York, Pennsylvania, New Jersey and New England to this meeting. All members of the society are invited to be present. The meetings will be held at the Chemists Building, 52 East 41st Street, New York, on each morning during the week to avoid conflict with the Tenth National Exposition of Chemical Industries. Among the plans for this meeting announced by D. H. Killeffer, secretary of the New York Section, are a symposium on the conservation of motor fuel, and an address by Dr. Alexander Findlay.

THE autumn meeting of the British Institute of Metals is to be held at Glasgow from September 1 to 4, under the presidency of Professor T. Turner, Feeney professor of metallurgy in the University of Birmingham. The proceedings commence with the fourth autumn lecture, by Sir John Dewrance, who will take as his subject "Education, research and standardization." Sixteen papers on various aspects of the constitution and properties of metals and alloys are to be submitted for discussion at the meeting.

THE first international congress on malaria will be held at Rome from October 4 to 6, under the presidency of Professor Marchiafava. The subjects to be discussed are: anopheles and malaria, the biology of the malarial parasites, the alkaloids of quinine and the treatment of malaria, and the epidemiology and statistics of malaria. Further information can be obtained from the general secretary, Professor Bastianelli, Via XXIV Maggio 14, Rome.

AT the first International Congress of Radiology held from June 30 to July 4, at London, England, under the presidency of Dr. Charles Thurstan Holland, an international committee was constituted comprising Professor Görsta Forssell, Stockholm, Sweden; Dr. Charles Thurstan Holland, Liverpool, and Dr. Stanley Melville, 9 Chandos Street, London, W. 1, secretary. The next international congress will be in Stockholm in 1928.

AN Esperanto summer school is being held at Geneva, and on August 12 the Eighteenth Congress of Esperanto, in which 25 organizations, four governments—Austria, Germany, Spain and the Netherlands—and the League of Nations took part, was opened.

THE budget of the University of Paris has appropriated 600,000 francs for the work and upkeep of the new Institute of Radium and the laboratory of physical chemistry.

AN appeal for funds to rebuild the laboratory for colonial botany of the University of Paris, which was destroyed by fire last June, has been issued by the French Association for the Advancement of Science, 28 rue Serpente, Paris, 6e. Subscriptions should be sent to M. Rivet, secretary of the Council.

ELI LILLY & COMPANY, manufacturers of pharmaceutical preparations, has arranged with Indiana University to donate $1,200 a year for five years to be used in research work. The fund will go to the department of surgery the first year. Dr. Willis D. Gatch will have charge of the work.

DURING the recent meeting of the American Ceramic Society in Canada, Alexander Silverman, of the University of Pittsburgh, announced that through the generosity of Isaac W. Frank $50,000 had been given for the establishment of the first laboratory of glass technology in an American institution of higher learning, according to *Industrial and Engineering Chemistry*. This is in memory of William Frank, father of the donor, and one of Pittsburgh's pioneers in the glass field. It is expected that an additional amount will later be added to the original gift. The laboratory is to be a part of the chemical department to be located in the new Cathedral of Learning, the fifty-two story building which the university plans to begin building this autumn.

THE fellowship in medicine established at the University of Michigan by Frederick Stearns and Company, Detroit, in honor of the late Frederick Kimball Stearns, will be devoted during the coming year to researches on insulin and insulin therapy.

THE British Empire Cotton Growing Corporation has decided to establish a central cotton research station in Trinidad. It is intended to investigate there the cotton plant in all phases of its growth and under rigorously controlled conditions, in order to ascertain and estimate the importance of several factors which contribute to the final result. The intention is to breed out pure lines for special characteristics. These will be tested locally in different parts of the world to ascertain if they are satisfactory in any particular country so that that country can raise its own seed. It is also hoped that the central station

will provide a scientific link between growers and manufacturers.

THE Bureau of Chemistry, U. S. Department of Agriculture, is now prepared to supply standard substances that conform to the biologic assay requirements of the Tenth U. S. Pharmacopeia, according to the *Journal* of the American Medical Association. Manufacturers are invited to apply, indicating the amount of material they desire against which to check their biologic assays. The new Pharmacopeia will state in the preface that biologic assays have now been made compulsory for a number of important drugs and preparations, and to facilitate the adoption of these standards and to provide a greater degree of uniformity in the application of these assays, the officials of the Bureau of Chemistry have indicated their willingness to supply substances conforming to the new standards. This service is the result of cooperation between the committee of revision, the manufacturers and the Bureau of Chemistry.

THE *Journal* of the American Medical Association writes that the degree of bachelor of science in hygiene will not be given after this year at the Johns Hopkins School of Hygiene and Public Health. The elimination of this degree will make the institution virtually a graduate school. Although conforming to the policy announced by the university last winter, Dr. William H. Howell, assistant director, said the step was taken largely to meet conditions outside rather than to follow the general scheme proposed by the president. This is the third step in the return of Johns Hopkins to its original standard as a graduate institution, the previous ones having been the proposal at Homewood to drop the first two years of college work and with them the A.B. degree (practically eliminating the College of Arts and Sciences), and the decision of the medical school to admit only those highly prepared. The degree of bachelor of science in hygiene was originally to train public health workers. Student candidates with two years of college work were instructed in special subjects for two years more at the School of Hygiene and Public Health, making the course four years in all. There have been a limited number of openings for the bachelors of science in hygiene, and therefore an increasingly smaller number of candidates for the degree. The new School of Hygiene will move into its new building in the hospital group about October 1. The celebration will be delayed until 1926, when the university observes its fiftieth anniversary.

Nature writes, "The German Chemical Society has recently published a 'warning' directing attention to the very large numbers of young chemists now coming from the universities, many of whom are unable to find suitable employment. Figures are given showing the extraordinary increase in graduates from the chemical faculty, as compared with those from other departments of the universities. It is anticipated that the number of chemical graduates this year will be about 1,100, whereas it is computed that German industry is only able to absorb about one third of that number, that is to say, about 350 per annum. Opportunities abroad for German chemists are now considerably less than they were before the war, partly for political or sentimental reasons, and partly because of the growing tendency in most countries having industrial aspirations to develop their chemical industry by employing their own chemists to the almost total exclusion of the foreigner."

UNIVERSITY AND EDUCATIONAL NOTES

THE greater part of the estate amounting to $2,300,000 of the late Edward Rector, the attorney of Chicago, is bequeathed to De Pauw University, at Greencastle, Ind., of which he was a trustee. Annual scholarships at De Pauw for every high school in Indiana were included in the bequest. At the time of his death, five hundred of its eighteen hundred students were being educated at the expense of Mr. Rector. The will provides for the addition of $100,000 for the retiring allowance of faculty and administration members, and for two dormitories, one for men and one for women, each to cost $250,000. About $1,700,000 is to be added to the Edward Rector scholarship fund, founded in 1918, with an endowment of $1,000,000. One of his benefactions is a fund, placed at the disposal of the university authorities, whereby money may be loaned to Rector scholars for living expenses. These loans may be repaid after graduation.

WITH $7,000,000 raised of the total of $10,000,000 necessary for the erection of the 52-story "Cathedral of Learning" of the University of Pittsburgh, the university trustees have appointed a building committee which is making preliminary surveys on the site. It is expected that ground will be broken in October, and that the remainder of the cost will be obtained in the near future. The university stadium, which has just been completed at a cost of $2,100,000, is being used for university athletic contests this fall. Its seating capacity is 70,000.

THE Johns Hopkins School of Hygiene and Public Health moved from its old site on West Monument Street to its new building at East Monument and Wolfe Streets on August 13.

SIR RICKMAN GODLEE, the well-known surgeon, who died on April 20 at the age of seventy-six years, left subject to a life interest for his wife the residue of his estate to University College, London, and to University College Hospital. The gross value of the estate is £94,148. Among special bequests is £10,000 to endow scholarships for students of the University College Hospital Medical School.

PROFESSOR HENRY T. MOORE, professor of psychology at Dartmouth College, who recently was elected to a professorship in the University of Michigan, has been elected president of Skidmore College, vacant through the death of the late Charles H. Keyes.

ALBERT BRITT, of the Frank A. Munsey Publishing Company of New York City, previously for fourteen years editor of *Outing*, has been elected to the presidency of Knox College, of which he is an alumnus, to succeed Dr. James L. McConaughy, who was recently inaugurated as president of Wesleyan University.

THE American University, at Washington, D. C., which has long existed as only a graduate school, and which during the war gave over its campus and buildings to government use, has again resumed control of the campus and will this autumn open a college of liberal arts, with Dr. Geo. B. Woods as dean; Dr. J. W. Hornbeck, recently of Carleton College, has been appointed professor of physics; Mr. F. A. Varrelman, recently biologist to the National Research Council Marine Investigations and special assistant of the Bureau of Fisheries, as assistant professor of biology, and Dr. E. W. Gurnsey, of the Fixed Nitrogen Laboratories of the Department of Agriculture, instructor of chemistry.

DR. ERNEST C. LEVY, formerly director of public welfare for the city of Richmond, Va., has been appointed professor of preventive medicine in the medical college of the University of Virginia.

DR. ARCHIE GARFIELD WORTHING, of the Nela Research Laboratory, Cleveland, Ohio, has been appointed professor and head of the department of physics of the University of Pittsburgh, succeeding Dr. Lee Paul Sieg, who has been made dean of the college and graduate school.

DR. ELMER O. KRAEMER, national research fellow in colloid chemistry, has been appointed assistant professor to conduct research and give instruction in colloid chemistry at the University of Wisconsin.

DR. VICTOR F. HESS, associate professor of experimental physics in the University of Graz (Austria), has been promoted to a full professorship. Professor Hess was director of the research laboratory of the U. S. Radium Corporation, New York, 1921 to 1923 and also consulting physicist to the U. S. Bureau of Mines.

J. S. HUXLEY, fellow of New College, Oxford, and senior demonstrator in the department of comparative anatomy, has been appointed to the university chair of zoology tenable at King's College.

DISCUSSION AND CORRESPONDENCE

EVOLUTION IN THE PHYSICAL WORLD

IN a recent number of SCIENCE (July 17) Professor Henry Fairfield Osborn states that "in chemistry and physics the evolution of the chemical elements has recently been demonstrated." What does Professor Osborn mean? Probably this, that we have rather recently learned that there are units or entities called electrons which help to form the atoms of all elements, and perhaps that there are other units or entities which some scientists have called protons which may also be constituents of all atoms so that we now picture the atoms of different elements as differing only in the number and arrangement and motions of these two kinds of entities. Probably also Professor Osborn has in mind the phenomenon of radioactivity which is exemplified chiefly by radium in which we see transformations going on and by means of which a complex atom breaks down and changes over into a simpler one. But are we justified in saying that we have *demonstrated* the *evolution* of the chemical elements? Certainly not in the sense in which that word is ordinarily used. Some of the changes taking place in radioactivity occur in minute fractions of time, others require ages, but all are associated with degeneration or changing from complex to simpler forms of matter. We have no evidence whatever for the opposite process, the building up from simple to complex and we have no evidence whatever that the atoms of chemical elements have by slow accretions acquired their present structure and characteristics. Does any physicist hold the view that electrons have come into existence only in recent times or that they gradually have selected partners and with these partners arranged themselves in groups to form our atoms of to-day? Perhaps so, but no physicist is giving much time to such speculation, for the vastly more important matter is to find out what is happening in the physical universe to-day. We can have no knowledge of the past except as we obtain it from our knowledge of the universe of the present.

And this brings me to emphasize one point which is not stressed in texts or courses on evolution. There are evidences everywhere that changes have taken place in the organic world, but to account for those

changes we assume that the modes in which nature operates now have not changed—that the laws of nature by which these changes have been brought about are unchanging. If we do not make this assumption, if we assume on the other hand that the laws of nature or the modes in which we see nature now operating are themselves subject to change or are themselves undergoing evolution, then we must know the manner of change or the law of change of the laws—either that or we must be free to postulate any law of change that we please, in which case we can build up any theory of evolution that suits us.

For example, has matter recently acquired the property of attracting to itself other matter, has an electric charge gradually taken on the power of attracting or repelling other charges, has energy recently acquired its characteristics? Or did Newton when he stated the law of gravitation state a property of matter, which, so far as this little mind of ours can picture the universe of time and space, holds forever and forever? We may find that Newton's statement was incomplete, but such a discovery, if made, will not point to evolution in gravitation but to evolution in our comprehension of the phenomenon. So we come to view our universe as one of constant change subject to unchanging law. In physics we are dealing with the eternal verities.

Another view which is ordinarily not presented in discussions on evolution is that our universe is like a clock which having been wound up is now running down. For it is a clearly established law in physics that when transformations of energy take place—and they are always taking place—energy, though conserved, becomes unavailable. Thus in accounting for our universe we must start with it already wound up—filled with a vast quantity of high-grade energy—then with a suitable hypothesis, we may acquiesce in the nebular theory according to Laplace or the planetesimal according to Chamberlain or the spirally nebular according to Jeans and thus we may account for the so-called growth of worlds. It is true that going back only a few hundred million years we can joggle along comfortably, flinging off spiral nebulae here and there, on the way down. But we don't care to be questioned too closely regarding events before that time. I think that the opponents of evolution are justified in saying that we do not know what happened long ago, but while they would mean by that term a few thousand we would mean many million years.

The idea that there has been evolution in the physical world is not new. Many philosophers have proposed it. The clearest enunciation probably was given by Descartes three hundred years ago—"the physical world and all things in it whether living or dead have originated out of primitive formless matter by a process of evolution due to the continuous operation of physical laws." But at that time practically nothing was known about physical laws. Not even the law of gravitation was known; nothing was known about electricity or light. Yet vast ignorance of all nature's operations did not prevent Descartes from propounding his broad philosophy. Philosophers are not disturbed by ignorance of facts, but scientists have no other basis for their generalizations.

The teachers of evolution are, I am afraid, apt to extend the meaning of the word beyond the original and to see *evolution* in the illumination produced by the striking of a match. This phenomenon is not unlike that associated with the so-called birth of a star. But if we want to know what happens when a match is struck or a star is born we must study physics and chemistry not evolution.

G. F. HULL

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NOTE ON THE SEPARATION OF THE DEPRESSOR PRINCIPLE FROM HEPATIC TISSUE

THE action of water soluble substances prepared from hepatic tissue in lowering the blood pressure of normal animals has been noted in the literature many years previous. Investigations as to the chemical nature of this principle which were initiated in this laboratory and the department of physiology eighteen months ago by Drs. James and Laughton have yielded the following results.

The active principle is non-protein in character and is found in the abiuret fraction. It is soluble in water alcohol solutions up to 80 per cent. strength. It is precipitated from aqueous solutions by phosphotungstic acid along with the diamino acid fraction, and the material recovered in aqueous solution can be further purified by extraction with ether, which has the capacity for dissolving out a very active principle which depresses the arterial tension and maintains it at sub-normal levels for long periods.

The depressor substance is associated with a pressor principle in the abiuret fraction. These two are separated during the treatment with phosphotungstic acid, since practically all the pressor element remains in solution.

Not only is the normal pressure reduced to subnormal levels, but artificial hypertension induced by various well-known pressor substances is similarly reduced to any desired level depending on the dose employed.

A. A. JAMES
N. B. LAUGHTON
A. BRUCE MACALLUM

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THE EFFECT OF NOISE ON HEARING

REFERRING to the effect of noise on hearing, Correspondent "B" in SCIENCE of March 6, 1925, page 260, proposed a theory which, to use his words, "seemed reasonable." For his information, and for the information of others who have been interested in the discussion, I shall present a couple of cases in which "a more or less regular succession" of vibrations is employed to jar a mechanism having a vibration of its own, to a state of higher sensitivity.

The power delivered by a steam turbine is governed by a valve controlling the admission of steam to the turbine. If the demand made upon the turbine must be continually varied in accordance with varying conditions of the system of which the turbine is a part, the movable part of the valve must function quickly and smoothly, in order to supply the turbine with the proper amount of steam at any instant. This part has therefore been made to move, in many such turbines, with a continuous oscillatory motion, at all times. In this way the response is quickened and sticking avoided. The actual or total motion consists of a sort of high frequency wave of small amplitude superposed upon an irregular wave of greater amplitude. The amount of steam admitted is practically the same as if only the larger wave were followed, but it is found that the auxiliary agitation augments the sensitivity.

The second example of the application of the same principle is connected with my own work.

Signals from ocean cables are ordinarily recorded by means of a "siphon recorder" upon a moving paper tape. The incoming impulses are weak, and the friction of the "pen," or siphon, upon the paper, is comparatively great. Consequently an arrangement is provided whereby the siphon can be kept constantly agitated with infinitesimal vibrations. The friction is thus considerably reduced, and the sensitivity increased. Greatest sensitivity is obtained when the direction of the vibrations is perpendicular to the plane of the paper.

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A LUMINOUS SPIDER

ONE day in Central Burma the trail in the jungle was exceptionally difficult. It was long past noon when I realized that the return journey would be equally long and tiring.

Camp lay on the other side of a long range of hills and there was a short cut from the main trail that would save several miles, but this trail was faint. I reached the supposed cut-off about dusk and followed it upward. Darkness came on swiftly and my pony began to stumble. Somewhere we had missed the trail, for at intervals I could still glimpse the crest of the hills and I knew my general direction.

Fireflies sparkled here and there. Presently a few feet away I saw a ball of light as large as one's thumb. It was stationary. Tying the horse, I approached it as carefully as possible, finding it surrounded by thorny bushes. It did not move and I pressed the brush aside until I was directly over it and then struck a match. There in full view was a spider, his large oval abdomen grayish, with darker markings. Still he did not move, and as the match died out his abdomen again glowed to full power, a completely oval light, similar in quality to that of the fireflies. Remembering native tales of poisonous insects, I wrapped a handkerchief around one hand, parted the brush with the other, and when close enough made a quick grab. Alas! The handkerchief caught on a stick before I could encircle him and my treasure scurried away. I followed as quickly as possible, but the light soon disappeared under stones, brush or in some burrow, for I never saw it again.

Many nights I searched in the jungle and questioned natives and white officers who had passed through that district, but apparently no one else had reported a luminous spider, nor can I find record of any known elsewhere.

Burmese never leave their houses after dark on account of their fear of spirits, so it is not surprising that the natives had never seen one, but some other traveler may be so fortunate as to capture one of these spiders.

The place where I saw the specimen was between the villages of Kyawdaw and Thitkydaing, Pakkoku District, about one hundred and twenty miles west of Mandalay, Burma, in April, 1923.

BARNUM BROWN
AMERICAN MUSEUM OF NATURAL HISTORY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR OBTAINING DIRECTLY THE SECOND DERIVATIVE OF A CURRENT-VOLTAGE CHARACTERISTIC CURVE[1]

THERE has been much discussion of the criteria to be adopted for determining critical potentials from the current-voltage curves of the hot-cathode discharge. Most of the refinements which have been proposed have been little used. In general, the attempt is made to locate as precisely as possible the

[1] Published by permission of the director of the Bureau of Standards of the U. S. Department of Commerce.

position of a maximum, a flex or a "kink," as the case may require. It is often difficult to judge accurately the position of such points. To locate maxima, the device of drawing the curve $\frac{di}{dv}$ is sometimes adopted. (i and v are the current and potential, respectively.) This is unsatisfactory, because the values of $\frac{di}{dv}$ in the vicinity of a maximum are obtained as a small difference of two large numbers.

Dymond[2] has devised a method for recording directly and precisely a curve which is practically identical with that of $\frac{di}{dv}$ plotted against voltage. A small alternating potential Δv is superposed on the potential v by means of a commutator. During one half revolution of the commutator the current has the value $i+\Delta i$; during the other half, it is $i-\Delta i$. The current is now passed through a second commutator rotating on the same shaft as the first. The commuted current is $i+\Delta i$ during the first half-cycle and $-i+\Delta i$ during the second. Thus, it is equivalent to an alternating current i superposed on a steady current Δi, and gives deflections proportional to Δi on a long-period galvanometer. Dymond suggests that a transformer or a bridge could be used to suppress the current i before the commutation, but in practice he found that this current was not large enough to injure his galvanometer and that it did not affect his readings.

This note describes a method for recording directly the curve $\frac{d^2i}{dv^2}$. Of course, the zeros of this curve give the positions of flexes of the $i-v$ curve. Suppose that an alternating potential Δv, obtained either from a transformer or from the first commutator, is superposed on v as before and that the second commutator is omitted from the circuit. Let the steady current i be carefully balanced out. Then the currents passing through the galvanometer during the first and second parts of the commutator cycle are, respectively,

$$\Delta_1 i = \frac{di}{dv}\Delta v + \frac{1}{2}\frac{d^2i}{dv^2}(\Delta v)^2 + \frac{1}{6}\frac{d^3i}{dv^3}(\Delta v)^3 + \ldots$$

and

$$\Delta_2 i = -\frac{di}{dv}\Delta v + \frac{1}{2}\frac{d^2i}{dv^2}(\Delta v)^2 - \frac{1}{6}\frac{d^3i}{dv^3}(\Delta v)^3 + \ldots$$

The corresponding expressions for the case of a sine wave are easily written down. The galvanometer will record $\frac{1}{2}\frac{d^2i}{dv^2}(\Delta v)^2$ with a high degree of approximation.

[2] Proc. Camb. Phil. Soc. 22, p. 405, 1924; Proc. Roy. Soc. A, 107, p. 291, 1925.

In addition to its applications to critical potential problems, which are limited only by the inconstancy of the currents to be measured, it is thought that this method may prove valuable in studying the characteristics of thermionic devices, where detecting ability depends essentially on $\frac{d^2i}{dv^2}$.

ARTHUR EDWARD RUARK
BUREAU OF STANDARDS

SPECIAL ARTICLES

THEORY OF THE PROPAGATION OF SHORT RADIO WAVES OVER LONG DISTANCES

RECENT experiments by Taylor, to be published shortly, on the transmission of radio waves of wave-length from 3,000 to 16 meters over distances up to 10,000 miles, have brought to light new facts. Those of particular interest in the present preliminary note concern themselves with the change in the intensity of the received signal with the distance from the transmitter. It has been found that for wave-lengths shorter than 50 meters the received intensity decreased as the distance from the transmitter was increased, reaching a value too small to be observed at a distance of a hundred miles or so. With further increase of distance the received signal remained undetectable until a point was reached where the received signal became strong again, rising rapidly to a maximum and thereafter decreasing rather slowly. The length of the region of silence, which we may call the "skip distance," was found to increase rapidly as the wave-length decreased, being roughly 400 miles for wave-length 32 meters and 1,300 miles for 16 meters, for daylight transmission and specified conditions of transmission and reception.

In a simple theoretical explanation of these facts we distinguish two portions of the wave propagated from the transmitting antenna, one of which clings to the surface of the earth and decreases rapidly in intensity with the distance until it is lost, and the other which moves in an upward direction and experiences reflection from the Heaviside layer. This layer is assumed to be a dispersive medium with a critical frequency corresponding to a wave-length between 100 and 200 meters. This critical frequency results from the motions of the electrons in the earth's magnetic field as suggested by Appleton and by Nichols and Schelling. When plane polarized radiation with electric vector in the plane of incidence is reflected from such a medium into air anomalies will occur at the Brewster and Snell angles, the reflected intensity being zero at the Brewster angle and 100 per cent. at the Snell angle. It is assumed that the portion of the wave propagated upward is

polarized with electric vector in the vertical plane and that the "skip distance" marks approximately the Snell angle of total reflection from the Heaviside layer. When Snell's law was incorporated in a Lorentz dispersion formula with one critical frequency, there resulted a relation between the dispersion constants and the height of the Heaviside layer, the skip distance and the wave-length of the radiation. The substitution of observed values into this equation determined the various constants, and with these constants the equation was found to agree with other observed skip distances within the error of measurement. The height of the Heaviside layer above the earth during broad daylight came out about 150 miles and the number of electrons per c.c. 10^5. These are reasonable values and in accord with estimates of these quantities from other sources. The values do not depend at all critically upon the exact value chosen for the fundamental wave-length, changing only by a few per cent. when this is changed from 120 to 200 meters, for example. The reason for this lies in the nature of the dispersion equation and is brought about by the fact that the wave-length region below 50 meters is considerably removed from the fundamental wave-length. Various facts and details of fading are explainable on the theory. Absorption of the radiation has been considered, as well as the effect of the earth's magnetic field in rotating the plane of polarization of the wave.

A theory of reflection is perhaps scarcely tenable in the form just outlined, for the optical constants of the air in all probability merge gradually into those of the Heaviside layer. As a result of this the radio wave, instead of being sharply reflected at the layer, is bent along a curved path. Without further detail, suffice it to say that this modification of the simple theory may be made and still retain practically the same agreement with the observed skip distances and about the same values of the height and dispersion constants of the Heaviside layer. The theory therefore supplements without disturbance the accepted ionic refraction theory of long wave transmission developed by Eccles, Larmor and others.

A. HOYT TAYLOR
E. O. HULBURT

NAVAL RESEARCH LABORATORY,
"BELLEVUE," WASHINGTON, D. C.,
JUNE 25, 1925

CROWNGALL IN RELATION TO NURSERY STOCK[1]

As far back as records are available to the writers, it appears that a large percentage of apple nursery trees propagated by the root grafting method have been affected by enlargements, or overgrowths, most of which ordinarily develop about the union of stock and cion. Much difference of opinion has existed both as to the cause of these enlargements and their effects upon the plants. Following the discovery by Smith and his coworkers[2, 3] of the causal relation of *Bacterium tumefaciens* Smith and Town. to the production of galls, "tumor strands" and "secondary tumors" on various plants, and their demonstration of its parasitism on the apple, the enlargements so commonly found about the unions of apple root grafts have been rather generally attributed to the action of this organism, and the sale of crowngalled apple trees has been prohibited by law in many states. However, in recent studies of crowngall, Riker[4] and Robinson and Walkden[5] have succeeded in inducing the development of "tumor strands" and "secondary tumors" only in the region of rapid elongation near the growing points of their experimental plants. This work appears to minimize the potential importance of "tumor strands" and "secondary tumors" in relation to apple nursery stock. In view of the many important gaps in the knowledge of crowngall and of the importance to the fruit industry of the questions involved, various groups and individuals have cooperated in organizing a research project,[6] the aim of which is to investigate certain aspects of the crowngall problem, with special reference to its bearing upon the fruit industry.

One of the first lines of work started was an attempt to differentiate crowngall of apple from other

[1] Approved for publication by the director of the Wisconsin Agricultural Experiment Station.

[2] Smith, E. F., Brown, N. A., and Townsend, C. O., "Crown-gall of plants: its cause and remedy," U. S. Dept. Agr., Bur. Plant Indus. Bul. 213, 215 p., illus., 1911.

[3] Smith, E. F., Brown, N. A., and McCullock, L., "The structure and development of crown gall: a plant cancer," U. S. Dept. Agr., Bur. Plant Indus. Bul. 255, 60 p., illus., 1912.

[4] Riker, A. J., "Some morphological responses of the host tissue to the crowngall organism," *Jour. Agr. Res.*, 26: 425–437, illus., 1923.

[5] Robinson, W., and Walkden, H., "A critical study of crown gall," *Ann. Bot.*, 37: 299–325, illus., 1923.

[6] This project, which is supported financially by the American Association of Nurserymen and individual nurserymen in cooperation with the Iowa State College of Agriculture and Mechanic Arts and the University of Wisconsin, is being administered by the Crop Protection Institute through a committee consisting of Drs. I. E. Melhus (chairman), G. W. Keitt and M. F. Barrus. Coordinated research programs are in progress at the Iowa State College of Agriculture and Mechanic Arts and the University of Wisconsin.

abnormalities which may be confused with it. A preliminary report[7] on this phase of the work follows:

Malformations resembling certain types of crowngall and hairy root have been found at the union of apple root grafts which were made from cions and stocks treated with 1–500 mercuric cyanide, cut with knives dipped in 1–1,000 mercuric chloride, callused in clean sand and planted in steamed soil. Cultural and microscopic examinations failed to reveal the presence of the crowngall organism in these overgrowths. Other experiments have shown that fresh callus on apple grafts is not readily wet by water and have indicated strongly that it is not ordinarily an open infection court for the crowngall organism. These and other field experiments give added weight to the idea, which has been suggested from time to time, that gall-like formations, other than commonly known injuries by nematodes, woolly aphids, etc., may develop on apple nursery stock without the intervention of *Bact. tumefaciens*.

These and other considerations led us to initiate isolation and infection studies with the aim of determining the presence or absence of the crowngall organism in types of malformation found about the union on rejected nursery stock. Such studies are being made on apple trees which were discarded at the nursery because of malformations at the union (supposedly crowngall). So far, over 175 of these trees from seven nurseries in four states have been examined by making five attempts at isolations by the poured plate method, according to a standardized procedure, from the overgrowth on each plant studied. The technique used failed to reveal the presence of the crowngall organism in any of these plants. The efficiency of this technique was tested at frequent intervals upon crowngalls which had been produced by inoculation with *Bact. tumefaciens* upon apple nursery stock or by natural infection of peach or raspberry. Of 29 such plants thus studied, 27 yielded the crowngall organism, the identity of which was checked in each case by positive results from inoculation into tomato. The sharpness of differentiation in these results is surprising to the writers. From the nature of the situation, it would seem altogether unlikely that this degree of sharpness of difference will be maintained in further studies of rejected apple trees from various sources, since eventually a greater or less amount of typical crowngall will undoubtedly be encountered on such material. It is worthy of note that none of the malformations thus far encountered in the rejected apple nursery stock submitted to us for these studies were of the "soft gall" type.

[7] A more detailed account of this work is in process of preparation.

Of the several working hypotheses which might be advanced to conform with these results, the most promising one appears to be that the malformations dealt with on the rejected nursery trees were not induced by the crowngall organism. This suggests the further hypothesis that these overgrowths were merely incidental to the root grafting method employed in the propagation of this material. They appeared to have been associated in their development with imperfect unions and consequent disturbances in the translocation of water and food. Under these circumstances, from what is known of callus development, such malformations might be expected to occur.

In the event that these hypotheses prove to be correct, it appears that the chances of making more accurate diagnoses of crowngall will be much improved, and it may be possible to differentiate from the true crowngall problem an important confusing element. Furthermore, there appears to be promise that further investigation may lead to the satisfactory control of these overgrowths about the union. Such studies are in progress.

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NORTHERN CALIFORNIA CONFERENCE ON SCIENCE TEACHING

DR. EDNA W. BAILEY and Mr. Clyde M. Westcott, Pacific Coast members of the Committee on the Place of Science in Education of the American Association for the Advancement of Science, requested the school of education of the University of California to conduct two conferences on the problems confronting that committee. One was held in Berkeley, under the auspices of the summer session, on July 17 and 18; the other will be held at the Southern Branch in Los Angeles on August 3 and 4.

It was planned to make this a small working conference, composed of those who have certain responsibilities with regard to the teaching of science in this state. The plan outlined by Dr. Otis W. Caldwell, chairman of the committee, was used as a basis for the preparation of the program, which follows:

Friday, July 17

9:30 A. M.: General meeting and organization: *Chairman*, Professor George W. Hunter, Knox College, Galesburg, Illinois. Discussion: "Present situation in science teaching in California. What subjects are taught, where, when, in what year, in what sequence; the training of teachers and the load carried by teachers." Leader: Miss Elizabeth Bishop.

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